

sample post. Each such sending should be accompanied by the name and address of finder, and the locality at which the specimen was obtained.

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EXPLANATION OF PLATE XLIII.

Fig. 1. Outline of a damaged specimen of a male *Firola coronata*;  $\times \frac{1}{2}$ ; the missing parts added from Vayssière's drawing, in a broken line.

Fig. 2. A median tooth of the radula;  $\times 60$ .

Fig. 3. The base of the snout, viewed from in front, showing the eight preocular "thorns." *a*, anus; *f*, ventral fin; *g*, genital pore; *m*, mouth; *v*, visceral hump.

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ART. XXVIII.—*An Account of some Earthworms from Little Barrier Island.*

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[Read before the Otago Institute, 10th October, 1905.]

Plates XLI and XLII.

SINCE the discovery that the earthworms inhabiting the North Island are so different from those of the South Island, I have endeavoured to obtain material from outlying islands, and I was successful in interesting Mr. Robert Shakespear in the matter. To him I owe the specimens with which this paper is concerned, and to him I beg to tender my thanks.

Little Barrier Island is a small outlier due west of Great Barrier Island, which is itself due north of the Coromandel Peninsula, with which it appears to have been at some previous age in continuity.

Little Barrier Island is at present a sanctuary for native birds, and is uninhabited except by the family of Mr. Shakespear, who acts as conservator of the island.

The four species which I have received are—(1) *Rhododrilus parvus*, n. sp.; (2) *Dinodriloides annectens*, n. sp.; (3) *Diporochæta gigantea*, n. sp.; (4) *Diporochæta shakespearei*, n. sp.

Although these are characteristically New Zealand, they are not definitely North Island, forms, for, with the exception of *Dinodriloides*, species of the other two genera are known from the South Island; while *Diporochæta* has not hitherto been found on the North Island itself, though it belongs to the subfamily *Megascolecinae*, to which the characteristic North Island worms (*Tokea*) belong. *Rhododrilus* has been obtained from the Kermadecs, the Chathams, the Campbell

and Auckland Islands, as well as on both the main islands of this area.

It is too early at present to draw any conclusions, for we must wait for further supplies of worms from elsewhere in the North Island. I may, however, remark that, so far as our knowledge goes, *Rhododrilus* is a commoner genus in the North Island than in the South, where it has only been met with once (*Rh. minutus*). It is surprising that no species of *Tokea* have been received from the Little Barrier Island.

I am endeavouring to trace out the line of junction between the northern and southern fauna, and am satisfied that it lies somewhere towards the south of the North Island; and, so far as my observations have gone, this line coincides in a most remarkable manner with the line recognised by Dr. L. Cockayne separating a northern and more southern flora, that line being the parallel 38° S. "The northern region is specially characterized by Malayan and Australian elements, which we may term 'subtropical'" (letter from Dr. Cockayne).

Thanks to the kindness of Messrs. Gibbs, Buchanan, and others, I have received a fairly representative supply of worms from Nelson: they all belong to the genera *Maoridrilus*, *Plagiochæta*, *Octochætus*, and *Dinodrilus*. Further, from Stephen Island, in Cook Strait, I have obtained species of *Maoridrilus* and *Octochætus*. The specific identifications of these worms I have not yet worked out, but the genera are all characteristic of the South Island. From the neighbourhood of Wellington I have received a species of *Maoridrilus* and of *Neodrilus* from Professor H. B. Kirk, in addition to the *Octochætus michaelsoni* described by me in the "Proceedings of the Zoological Society" (1904, vol. ii, p. 225).

#### 1. *Rhododrilus parvus*, n. sp.

I received three specimens, which reached me alive, packed in damp moss. Only one of them is mature.

*Colour*.—When alive the thin body-wall is translucent, and, except for the blood-vessels, without colour, so that the opaque white coelomic fluid is visible. When preserved the worm is, of course, white.

*Dimensions*.—In comparison with the other members of the genus recently examined by me this is a small form. These three individuals measure from 55 mm. by 3 mm. (in alcohol) to 65 mm. by 2 mm. (in formol). The latter contains 120 segments, which are annulated.

The *chatal* formula is  $ab = cd < bc$ ;  $aa = bc$ ;  $dd = 2ab$ .

The *clitellum* occupies segments 14–17.

The *male pores* are in small papillæ in line of *b*.

The *tubercula pubertatis* are paired, in line with *a*, and, as in some other species, are in considerable numbers, namely, 10/11, 13/14, 14/15, 15/16, 18/19, 19/20, 20/21, 21/22. Each of these appears as a smooth rounded swelling, joined across the middle line by a slight ridge.

A single pair of *spermathecal pores* lies in line *b*, at 8/9.

*Nephridiopores* are also in line *b*.

*Internal Anatomy*.—There is nothing characteristic in regard to the alimentary system.

The testes and funnels and sperm-sacs are in the usual segments, but the anterior pair of each is smaller than the posterior pair.

The prostates extend to segment 23, and the penial sac into the 24th.

The penial chætæ are thus of considerable length, as in *R. besti*, but in form recall those of *R. leptomerus*. The chæta is delicate, curved, and terminates in a simple point, which appears to be flexible; at any rate it is sharply recurved in the specimens mounted.

The single pair of spermathecae lies in the 9th segment; the main sac is ovoid; the diverticulum cylindrical, not quite so long as the sac, and opens into the upper part of the short duct.

*Loc.*—In banks of streams in dense bush.

## 2. *Dinodriloides annectens*, n. sp.

I was very interested to meet with this genus again, as the type was the solitary individual obtained.

This second species is rather larger than the first, measuring 90 mm. by 3 mm. for 102 segments.

*Colour*.—When alive the worm is dark sienna-brown, so dark anteriorly to the clitellum as to appear nearly black. The whole dorsal surface of the body is pigmented down as far as chæta *d*—i.e., the whole upper half of the body. The ventral surface is, of course, paler than the dorsal. The clitellum is much lighter brown, and the areas round the genital pores and the tubercula pubertatis are yellow; the chætæ arise from pale spots. After being in alcohol for longer than a year the colour has changed to bluish-grey, as described in the case of the previous species, *D. beddardi*,\* which probably when alive is coloured dark-brown.

There is so close a resemblance between the two that for some time I supposed this new species to be merely a second specimen of the previous one. But there are one or two points of external anatomy in which this specimen differs from the type, though I can detect no differences in internal structure.

\* Proc. Zool. Soc., 1904, vol. ii., p. 226.

so far as may be seen by dissection merely. Nevertheless, I believe that these external differences (which concern the position of genital pores, &c.) are sufficient to justify the bestowal of a new specific name, on the analogy of the differences between species of the European genera *Eisenia*, *Lumbricus*, &c.

*Genital Pores.*—The male pores, on porophores, are outside chæta *b*. Each porophore is sunk in a pit (due perhaps to mode of preservation, but suggestive of mobility in life).

There are two circular *tubercula pubertatis* on segment 16, one behind chæta *a*, which touch mesially. A second pair on the 18th segment are in line *a-b*, and do not touch. A comparison with the arrangement in *D. beddardi* will show that considerable differences exist in regard to the position of these and the following structures in relation to the chætae. Further, a well-marked ridge (? due to contraction or shrinkage of the gland), pale in colour, surrounds these four glands and the porophores. This ridge has a somewhat hexagonal form. It is transverse on the hinder margin of 15, extending from *b-b*; then, at each end, bends rather sharply backwards to the outer side of the porophores in 17, passing at the level of *c*; thence curving inwards between the chætae *c* and *b* on segment 18 to meet its corresponding half on the hinder margin of this segment.\*

The *oviducal pores* are immediately in front of chæta *a*, whereas in the type they lie in front of the gap *ab*.

The *spermathecal pores*, at 8/9, are in line with *b* (instead of with the gap *bc*), and behind it is a tubercula pubertatis, on segment 9, in line with *a*.

*Loc.*—Bank of stream in dense bush.

### 3. *Diporochæta gigantea*, n. sp.

A single specimen of this titanic worm was forwarded to me.

*Colour.*—White (when preserved in formol), with the anterior end purplish-grey, and a narrow band of the same colour running along the dorsal surface about as far as the middle of its length.

*Dimensions.*—When measured after preservation its length is 990 mm. by 11 mm., but Mr. Shakespear writes me that it measured 4 ft. 6 in. when extended alive. This is a great size for an earthworm, though larger ones are known—*e.g.*, *Megascolides australis* attains a length of 6 ft. when alive, though its average size is said to be 4 ft. There is a large

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\* In the case of *D. beddardi*, a re-examination of the type shows that I overlooked three medium tubercula on segments 11, 12, and 13, of which I find no evidence in the present species.

worm, *Glossoscolex giganteus*, in Brazil which when preserved measures 4 ft., and *Microchaetus microchaetus* from South Africa attains nearly the same length. Naturally the length of a preserved worm depends a great deal on the method of preservation and on the preservative. The present specimen was preserved in strong formol, and is much contracted.

There are about 450 segments, perhaps more. I counted 200 in less than half the length, and then estimated the total; but, as the hinder ones are smaller, this number is only approximate. The segments are much annulated, and those at the anterior end are traversed by longitudinal furrows, cutting up the surface into small rectangular areas.

*Prostomium*.—The prostomium and 1st segment are so much furrowed that the limits of the former are not recognisable.

*Chætæ*.—There are from 56–60 chætæ per segment in the 16th segment and backwards, but in front of the clitellum the number is less; about 35 were counted on the 10th segment. I was unable to detect any chætæ anterior to the 5th segment under a lens; possibly they are entirely retracted. There is a dorsal and a ventral gap along the whole length of the body, wider anteriorly; thus, on segment 16 the dorsal gap measures 4 mm. and the ventral 2 mm., but before the mid-body is reached each gap is reduced to 1.5 mm., a width which is retained throughout the rest of the body.

The *clitellum* covers segments 13 to half 18 (*i.e.*, five segments and a half).

*Genital Pores*, &c.—The male pores, on the 18th segment, are at either end of a transverse glandular slightly prominent area which extends from chætæ *e* to *e*. The pore itself is small, inconspicuous, about in line with *e*.

Copulatory glands (*tubercula pubertatis*) are three in number, in the form of short, transverse, glandular areas, median, inter-segmental, extending from *c* to *c*, and situated at 16/17, 17/18, and 19/20.

There are two pairs of *spermathecal pores*, at 7/8 and 8/9. I did not note their position in regard to the chætæ.

*Dorsal pores* are present behind the clitellum.

*Internal Anatomy*.—There are much thickened septa behind segments 7–13.

The dorsal vessel is double from the 15th segment forwards to the 8th. The last of the three pairs of hearts is in segment 12. The hearts in 11/12 are connected with the dorsal and with the supra-oesophageal vessel; those in 10 are smaller, and open out of the latter vessel only.

The gizzard, in 5, is long. The oesophagus is dilated in 12

and 13; the lining is papillose, and there are no definite glands. The intestine commences in 16, and is without a typhlosote.

The intestine contained pieces of rotten wood measuring as much as  $\frac{1}{3}$ — $\frac{3}{16}$  in. in length.

*Reproductive Organs.*—There are two pairs of testes and funnels, in the usual positions, but those in segment 10 are much the smaller, and perhaps functionless, as there is only a single pair of sperm-sacs, which lies in segment 12.

The prostates are straight,\* subcylindrical, and occupy three segments. In this particular specimen the apex is directed forwards and lies in segment 16, but perhaps this is merely an individual peculiarity.

There is no definite duct. The gland retains nearly the same diameter up to the body-wall, when it suddenly diminishes as it dips into the muscles. Bundles of muscular fibres pass up from the body-wall and spread over the surface of the gland to form an imperfect sheath round its lower end.

No penial chætæ are recognisable.

There are two pairs of spermathecæ, in segments 8 and 9. Each is an ovoid pouch with a very short duct, not distinctly marked off from the sac. A small pyriform diverticulum opens into the duct close to the body-wall. The sac presents a peculiarity that I do not remember noticing in any other worm. Along both the mesial and lateral surface of the sac is a distinct muscular ridge; that on the lateral surface is larger and longer, extending right up to the apex, whereas the other one only reaches about half-way up. At the lower end these longitudinal muscle-bands spread out on the body-wall. These two ridges are very pronounced structures.

*Excretory System.*—The worm is micronephric, and herein differs from the majority of species of *Diporochæta*. In the genital segments the close-set little loops give a velvety appearance to the inner surface of the body-wall; but posterior to the 18th segment they become limited to a single row of small tubules running along the middle of the segment. But, although the nephridia are thus minute and multiple, the remains of a meganephric condition persist throughout the worm in the form of a pair of large funnels which project forwards from each septum. Each funnel is nearly as long as a segment—*i.e.*, in the contracted condition of the worm it reaches the preceding septum; it is thus readily visible. This funnel is V-shaped, with long parallel limbs, each consisting of an axis of vascular connective tissue, around which is arranged a single row of ciliated columnar epithelial cells, in a spiral fashion.

\* In the type of the genus, *D. intermedia*, they are coiled.

There is a general resemblance to the funnel of the "brown tubes" of *Echiurus uncinatus*.

*Loc.*—Bush-covered plateau, 600 ft. above sea-level.

Mr. Shakespear writes, "The curious thing about these large worms is that we never see any castings about. With this one a slight crack in the soil was noticed, as when a mushroom is coming through, but there was no hole coming to the surface. My daughters dug down about 2 ft. before they came upon the worm, the passage winding horizontally, but slowly going downwards. The soil is decomposed volcanic breccia, and fairly stiff."

*Remarks.*—I have included this worm in the genus *Diporochæta*, for it only differs from it in being micronephric. The genus was founded in 1890 by Mr. Beddard\* for meganephric worms with many chætæ and cylindrical prostates, and *D. intermedia*, from New Zealand, is the type; but since that time a number of other species have been described from Australia and Tasmania. Amongst these Spencer has included two worms having micronephridia—viz., *D. notabilis* and *D. maplestoni*, from Victoria, both of which, however, differ from the present species.

These certainly agree more closely with the typical *Diporochæta* than they do with either of the other Megascolecine genera in which many chætæ form a continuous series round each segment—viz., *Pheretima*, *Megascolex*, *Plionogaster*, and *Perionyx*. The first three are micronephric, but it is only to *Megascolex* that our species show any close resemblance, from which, however, it differs in the cylindrical character of the prostate.

I have already pointed out that within the Acanthrodriline genus *Plagiochæta*, which is normally meganephric, species (e.g., *Pl. rossi*) with small and multiple nephridia occur; and the presence of large nephrostomes in *D. gigantea* (and in the following species, *D. shakespearei*) indicates that the micronephric condition has only recently been evolved.

#### 4. *Diporochæta shakespearei*, n. sp.

This new species is founded upon the results of a study of about a dozen individuals.

*Colour.*—The living worm is pale-red—i.e., it is without pigment in the body-wall, so that the blood shows through. The clitellum is yellowish. When preserved either in alcohol or in formol the colour is opaque-white and the clitellum yellow.

*Dimensions.*—The formol specimens measure from 115 mm. by 4 mm. to 120 mm. by 5 mm., the latter having 195 segments.

\* Proc. Zool. Soc., 1890, p. 56.

Some of those preserved in alcohol, not being so much contracted, have a length of 130 mm., but this contains only 111 segments.

The *prostomium* is about a quarter epilobic.

*Chætæ*.—There are about fifty chætæ in each segment; thus, both on the 9th and 26th segments the number was forty-eight; in the mid-body and in one of the posterior segments I counted fifty-two and fifty respectively.

A distinct ventral gap is present throughout the body, but a dorsal gap only in the anterior region. Anteriorly to segment 20 the dorsal gap equals the ventral gap, but from this segment backwards the former decreases till it has disappeared before the mid-body is reached.

The ventral gap  $a-a$  = four interchætal gaps ( $ab$ ), both in mid-body and on segment 9.

The *clitellum* occupies segments half 13–17, and is complete.

*Genital Pores, &c.*—The male pores in segment 18 are carried on slight papillæ, each of which, in the formol specimen, rises from a well-defined pit about in line with  $bc$ .

There are two *tubercula pubertatis*, in the form of transverse glands, one near the anterior margin of segment 17, a second intersegmental at 19/20; each extends from about  $c-c$ . In the formol specimens these glands are well-marked transversely oval pits, with fairly well-marked margin, but in those preserved in alcohol they are much shallower depressions.

All the individuals, even those in which the clitellum is undeveloped, exhibit precisely the same arrangement—neither more nor fewer—of tubercula.

There are two pairs of *spermathecal pores*, at 7/8 and 8/9.

*Internal Anatomy*.—The septa behind segments 6 to 11 are thick.

The dorsal vessel is single, and the last heart is in 13.

The gizzard, long and cylindrical, in 5. The œsophagus is dilated in 11, 12, and 13; it is here thick-walled with lamellæ within, but there is no constriction from the main tube. The lamellæ, however, are similar to those in such glands as occur in *Maoridrilus*, and I think we may regard this dilated region as a gland.

The intestine commences in segment 16.

*Reproductive System*.—The testes and funnels are in the normal position. The sperm-sacs, two pairs, in segments 9 and 12.

The prostates—straight, tubular, with a roughened surface—extend through segments 18–24. The duct is long, straight, and narrow.



The spermathecæ, in 8 and 9, have a form common in the family; each is a pyriform sac with an ill-defined duct, into which opens a small pyriform diverticulum.

*Excretory System.*—Like the preceding species, this one is micronephric, but a fairly large funnel is present in each segment, of an elongated crescentic form, intermediate in form between the normal funnel and the long V-shaped funnel of *D. gigantea*.

Both this and the preceding species are provided with a pair of peptonephridia anteriorly.

*Loc.*—Bank of stream in dense bush.

#### EXPLANATION OF PLATES XLI AND XLII.

##### PLATE XLI.

The illustrations of the anatomy of the earthworms are purely diagrammatic, indicating only the segmental position of the various organs, the worm being supposed to be slit up along the dorsal line and the body-wall pinned aside. A group of three diagrams refers to each worm herein described.

The left-hand diagram in each of the groups referring to a species represents the external features. The location of the various genital pores is represented as round black dots (if on a papilla this is left white), the clitellum is obliquely shaded, the tubercula pubertatis are vertically shaded.

In addition, the arrangement of the chætæ is indicated in segments 5 to 23 on one side; they are omitted on the other side for clearness' sake. But only about half the true number of chætæ are indicated.

The middle figure represents the alimentary canal and so much of the vascular system as is diagnostic. The latter is black. The gizzard is indicated by vertical shading, the œsophageal glands by more or less horizontal lines. The intestine is not represented as being constricted, which is, however, the case in most worms.

The right-hand figure shows the reproductive system. The gonads are in black. The sperm-sacs are dotted. The muscular duct of the spermiducal gland is transversely striped.

No attempt is made to give the relative sizes of the worms or of the various organs.

##### PLATE XLII.

Figs. 1, 2, 3 are diagrammatic representations of the external anatomy of *R. parvus*, *D. annectens*, and *D. beddardi* respectively.

The location of the genital pores, clitellum, and tubercula pubertatis is represented, and the true relative spacing of the chætæ on one side, which are labelled *a*, *b*, *c*, *d*, &c.

The nephridiopores in *R. parvus* are indicated by the small circles on the right side of the figure.

Fig. 4. *Rhododrilus parvus*. Spermatheca.

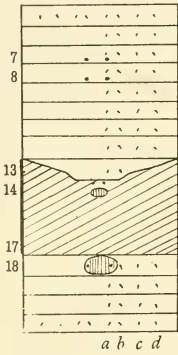
Fig. 5. *R. parvus*. A penial chætæ;  $\times 80$ .

Fig. 6. The same, tip enlarged;  $\times 480$ .

Fig. 7. *Diporochæta shakespear*. A spermatheca.

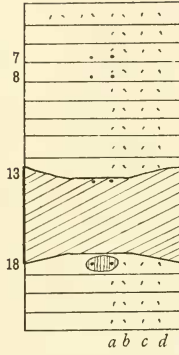
Fig. 8. *D. gigantea*. Spermatheca. *r*, *r'*, the two muscular ridges along the main sac.

Fig. 9. The same in transverse section, showing muscular ridge at each end.



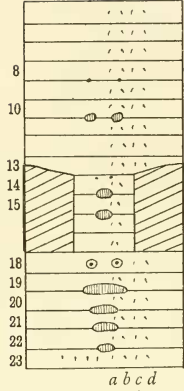
Tokeia maurica.

1



Tokeia decipiens.

2



Rhododrilus similis

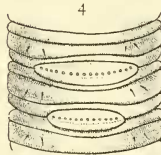
3



5



6



4



8



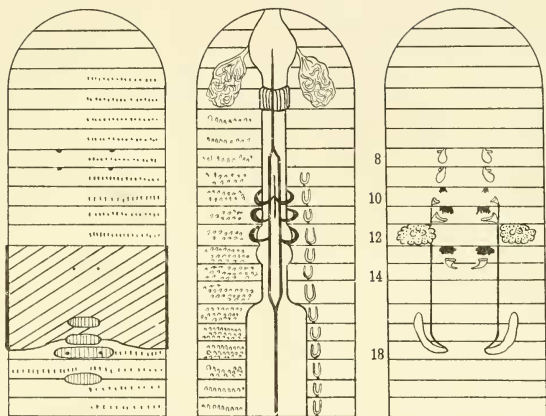
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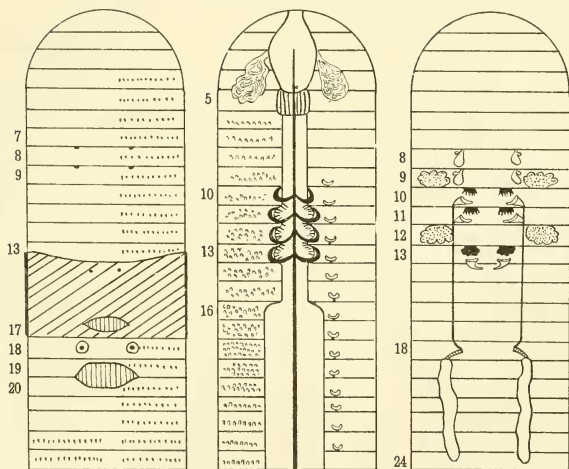
7



9



*Diporochæta gigantea.*



*Diporochæta shakespearei.*